



# Corpus Callosum: The Advantages of Art and Science Superposition



Michael Welter | SPS Communications  
Final Intern Symposium  
August 10, 2018

# Overview

Section 1: How drawing cultivated a scientist

Section 2: How physics cultivated an artist

Section 3: Combining art and science

Section 4: How superposition of art and science can influence the world



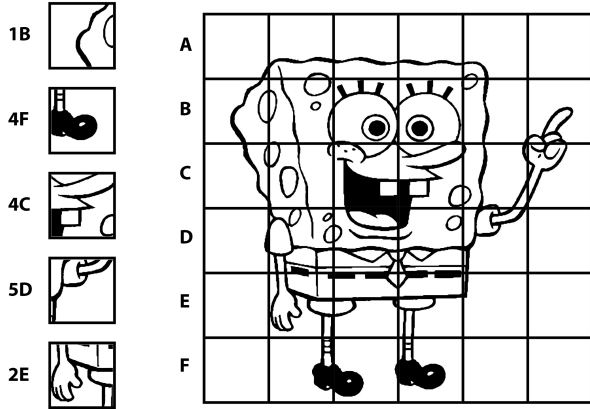


## Section 1: How drawing cultivated a scientist

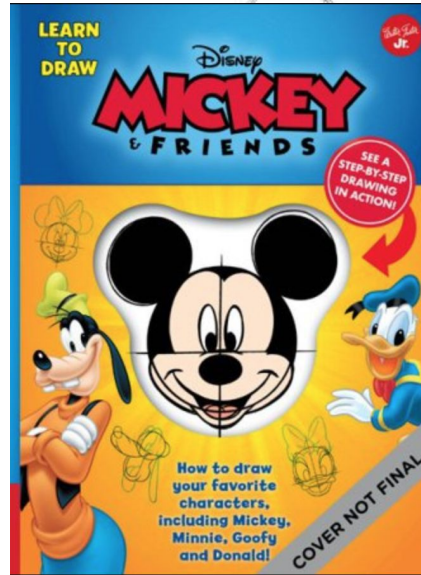


# Art education

STEM skills taught through drawing



Coordinate systems &  
Precision



Geometry & Scale



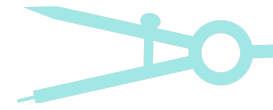
Spatial Reasoning &  
Anatomy



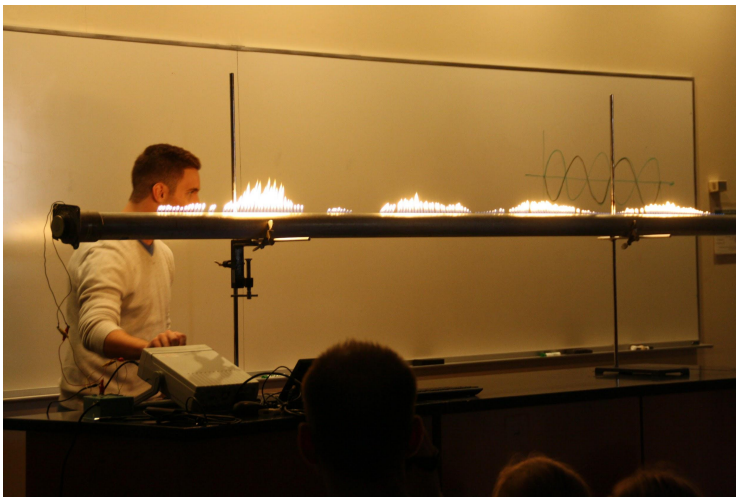
## Section 1: How physics cultivated an artist



# Pursuing Physics & Performing Research



# Tutoring, Outreach & Communication

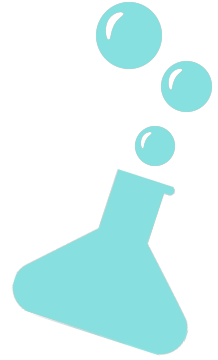




## Section 3: Combining art and science



# Science influencing Art



Kinetic sculptures

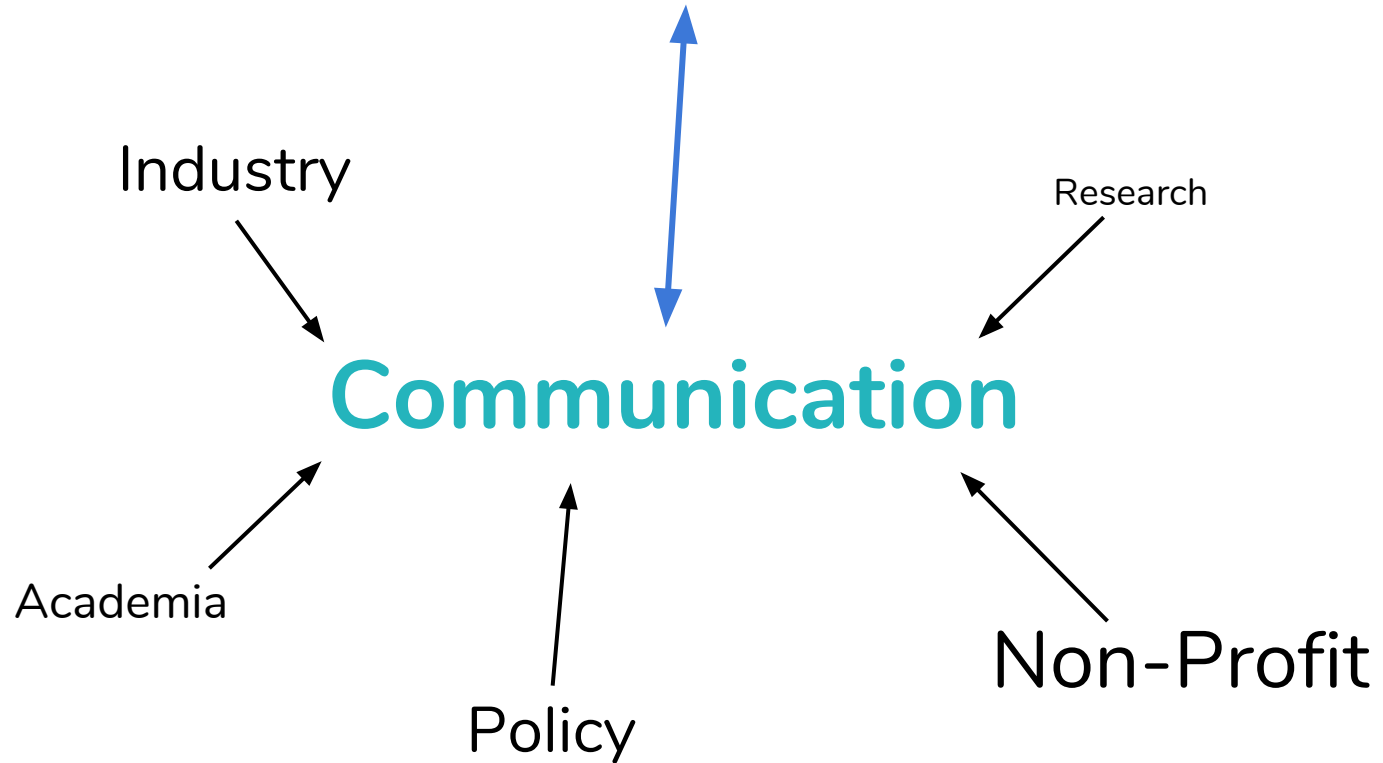


Architecture



Creative mediums

# Art influencing Science



# Effective **Visuals** using Graphic Design

Basic Principles:



# Effective Communication through Graphic Design

## Advanced Principles:

### Diffusion and Conformational Dynamics of Single DNA Molecules Crowded by Cytoskeletal Proteins

Kathryn Regan, Rachel Dotterweich, Shea Ricketts, and Rae M. Robertson-Anderson

Department of Physics & Biophysics, University of San Diego, San Diego, CA 92110

**Abstract.** The high concentrations of proteins crowding cells greatly influence intracellular DNA dynamics. These crowders, ranging from small mobile proteins to large cytoskeletal filaments such as semiflexible actin and rigid microtubules, can hinder diffusion and induce conformational changes in DNA. While previous studies have mainly focused on the effect of small mobile crowders on DNA transport, we examine the impact of crowding by actin filaments and microtubules. Further, because actin filaments and microtubules are formed by polymerization of actin monomers and tubulin dimers, respectively, we also investigate the role that the polymerization state of each protein plays in DNA transport and in the time-varying conformational changes of single DNA molecules diffusing in *in vitro* networks of polymerized and monomeric actin and tubulin. We find that crowding by actin monomers slows DNA diffusion, while tubulin crowding actually increases diffusion coefficients. Monomeric actin crowding DNA diffuses more than when actin is polymerized, while crowding by tubulin dimers increases DNA diffusion more than when tubulin is polymerized (microtubules). Further, we find unexpected relationships between DNA coil size and diffusion when crowded. All crowding conditions lead to some degree of DNA compaction, but less compaction enabled faster dynamics.

**Keywords:** DNA dynamics, single-molecule particle tracking, polymer dynamics, cytoskeletal crowding  
**PACS:** 87.14.gk, 87.16.ia, 87.80.Nj

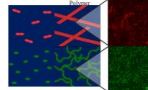
#### INTRODUCTION

The biological cell is a highly crowded environment, comprised of a wide variety of molecules that effectively crowd a molecule and prevent random intracellular movement [1]. The proteins that comprise the cytoskeleton are among the most important of these crowding macromolecules. The cytoskeleton, which supports cell shape, structure, and mobility, is composed primarily of thick, rigid microtubules (~10 $\mu$ m x 25nm), polymerized from tubulin dimers (10nm), as well as thinner, semiflexible actin filaments (~10 $\mu$ m x 10nm) comprised of globular actin monomers (~5nm) [2,3]. These proteins can greatly influence the mobility of nucleic acids as they traverse the cytoplasm and can induce conformational changes that impact that stability of DNA [1].

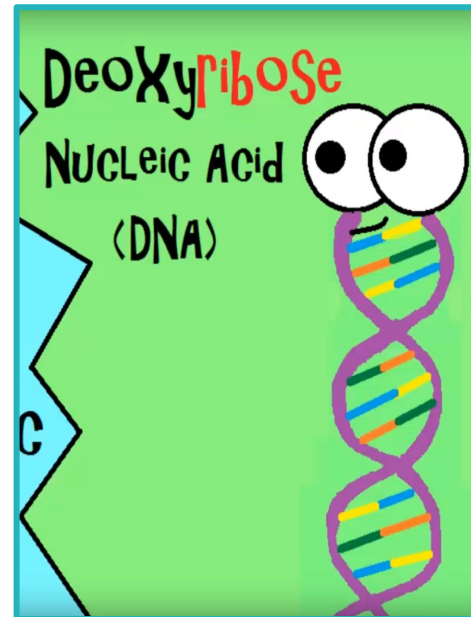
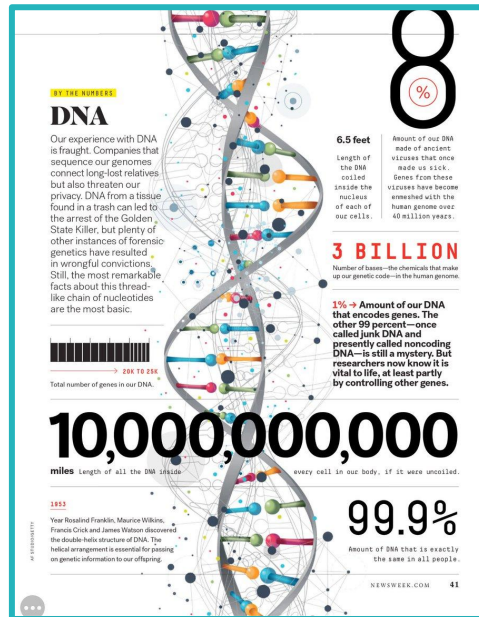
Indeed, cytoskeletal crowding has been identified as a key barrier to cytoplasmic transport of DNA [4,5] and influences important biological processes including replication and transcription as well as gene expression and delivery [1-6]. Though research has been done on how to introduce DNA into a target cell for gene therapy [7], little is known of how cytoskeletal crowding impacts the DNA dynamics and conformational stability needed for efficient gene delivery.

Here, we investigate the diffusion and conformational dynamics of DNA crowded by the cytoskeletal proteins actin and tubulin. We track single

DNA molecules diffusing in varying crowded solutions of actin and tubulin, in both monomeric and polymerized states. We find that cytoskeletal crowding compacts DNA and plays a complex role in DNA transport. Specifically, actin monomers slow DNA



**FIGURE 1.** Experimental Schematic. (A) DNA molecules assume a random coil configuration in solution. When labeled with fluorescent dye, the higher intensity denotes higher mass density. (B) Cytoskeletal proteins exist in either monomer or polymer form. Polymerized proteins exhibit unique structural composition, as evident from confocal microscope images.





## Section 4: Influencing the world

# Teaching without misleading



November 10th 2017 — 14K Shares

## Scientists Find That Wine And Chocolate Are The Secret To Beating Wrinkles



Mark McGowan in NEWS

Good news for those of us that like a slap of chocolate and a glass or nine of red of an evening - studies have found that they are the secret to staying youthful. No, really.



**DID YOU KNOW...?**

Honeybees will likely have been around for about 30 million years, and it's likely that they first appeared about 10 million years ago.

Honey bees have "fairy eyes" (compared to the compound eyes of other insects) that sense smell, gravity, and light navigation. Each foot of their legs is equipped to feel the texture of the surface.

Bees have the ability to fly at night, but they do not usually when they are foraging. They will be back foraging.

### silence of the buzz

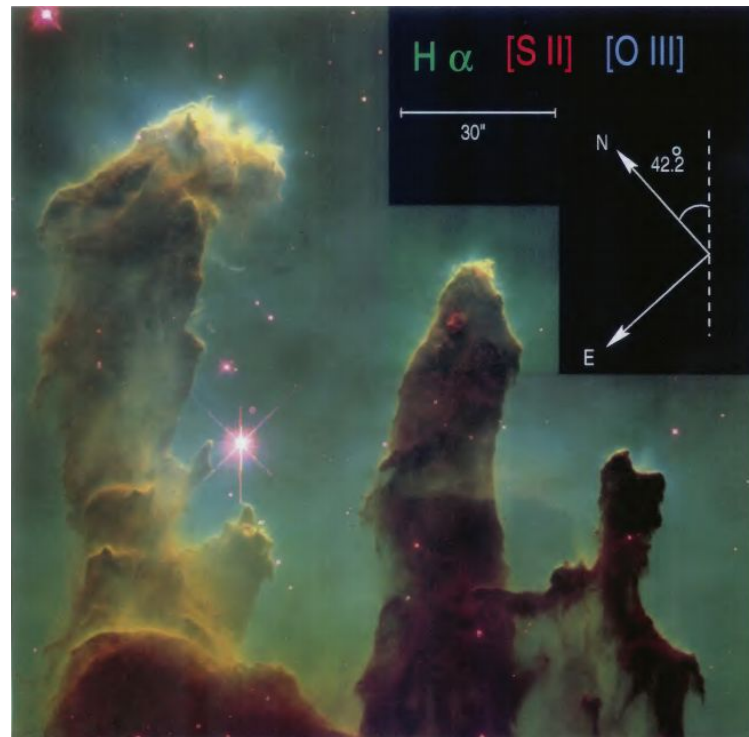
**Honeybees are not going extinct, but losses are increasing annually.**

**Why are bees in trouble?** Honeybees are disappearing at an alarming rate. In some areas, honeybees are disappearing at a rate of 30% per year. This is due to a combination of factors, including loss of habitat, pesticides, and diseases.

**Why do we need bees?** Honeybees are important for many reasons. They are the primary pollinators of many of our most important food crops, including almonds, apples, and blueberries. They also play a role in the production of honey and beeswax.

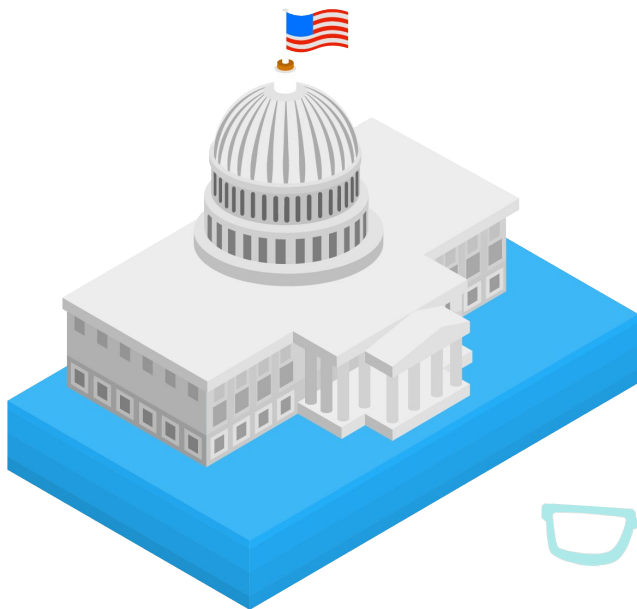
**How bees in your garden, community garden, or balcony?** Honeybees are important for many reasons. They are the primary pollinators of many of our most important food crops, including almonds, apples, and blueberries. They also play a role in the production of honey and beeswax.

**For more ways that YOU can make a difference in your community, visit [savebees.org/learn](http://savebees.org/learn).**



# Facts: at a glance

## Policy & Industry




# JURP

JOURNAL of UNDERGRADUATE REPORTS IN PHYSICS

### What is JURP?

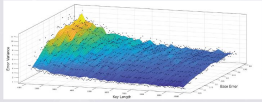
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JURP provides exposure for SPS members conducting physics research while also highlighting SPS members' participation in SPS programs, awards, and outreach.




### Research

- Peer-reviewed papers within any area of physics research.
- Accepted research submissions will be indexed and searchable.



### Programs


- Conference reflections, SPS chapter award final reports, SPS intern blogs, and other special programs articles.




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All current SPS members are eligible to submit to JURP. The author(s) must have performed all the work reported in the paper as an undergraduate student(s).

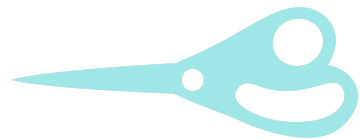
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**INTERESTED IN SUBMITTING YOUR RESEARCH OR REPORT TO JURP?**  
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# Inspiring and Empowering



Outreach & Education

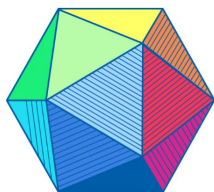
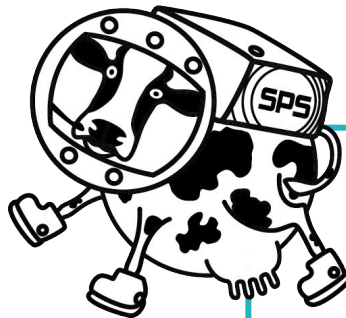
# Soek.



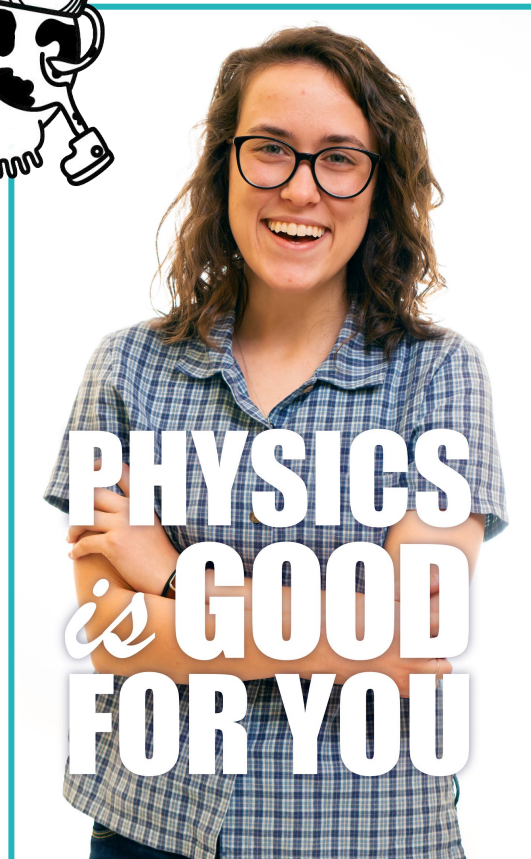
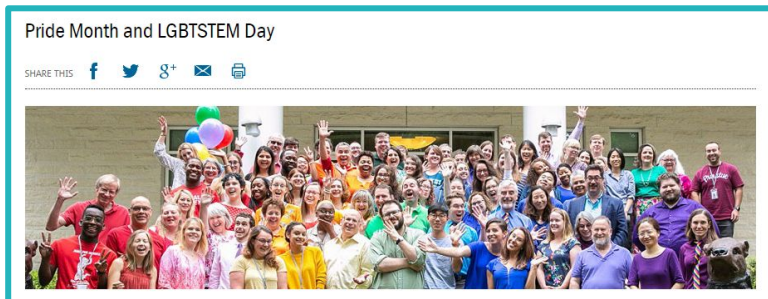
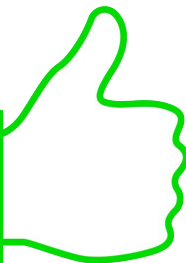


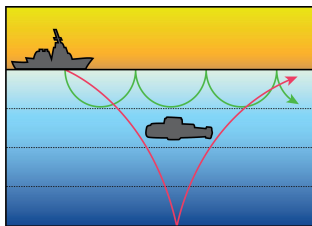
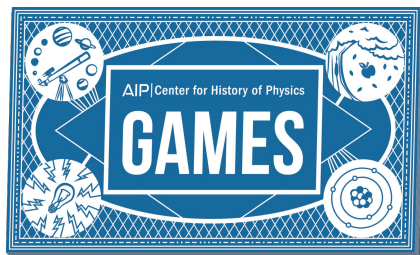
# Global Influences

1. Improve general attitudes towards science
2. Promote diversity & inclusivity

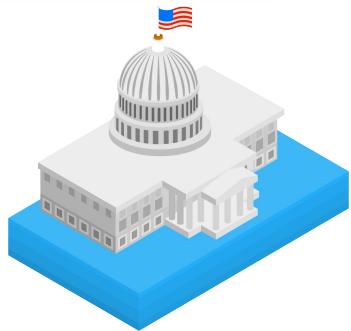


THUMBS FOR  
SCIENCE

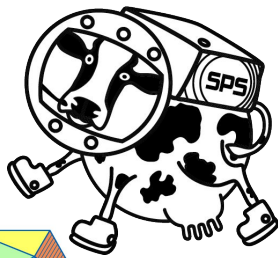




**THUMBS UP FOR SCIENCE**



**Soek.**  
science outreach catalyst kit



**PHYSICS JEOPARDY!**



SOCIETY OF PHYSICS STUDENTS

**APPLICATION DEADLINES!**

MARK YOUR CALENDARS!

The Society of Physics Students (SPS) and Sigma Pi Sigma (SPS) have established deadlines for research, scholarship, and membership. Please refer to the application or review these opportunities on a regular basis to help you prepare and submit on time.

Fall Deadline	Winter Deadline	Spring Deadline	Summer Deadline
<b>November 15</b>	<b>January 15</b>	<b>March 15</b>	<b>June 15</b>
<ul style="list-style-type: none"> <li>□ All About Me White Award</li> <li>□ The Edwin Powell Hubble Award</li> <li>□ SPS Chapter Research Award</li> <li>□ Sigma Pi Sigma Chapter Point Award</li> </ul>	<ul style="list-style-type: none"> <li>□ SPS National Internship</li> <li>□ SPS Congressional Visit Day</li> </ul>	<ul style="list-style-type: none"> <li>□ SPS Scholarships</li> <li>□ Outstanding Undergraduate Research Award</li> <li>□ Outstanding Chapter Advisor Award</li> <li>□ Journal of Undergraduate Research in Physics (last submission due by May 15)</li> </ul>	<ul style="list-style-type: none"> <li>□ Chapter Report including the Blog Life Post</li> </ul>

Display Opportunities: SPS Postcard, SPS Research Report, Contact Us Request

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Programs

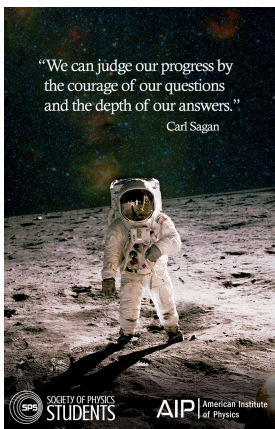
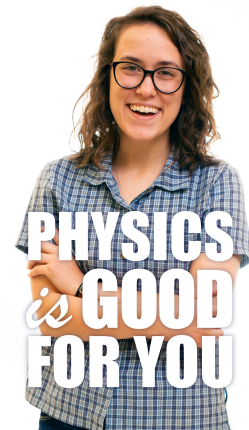
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**MEN'S CUT T-SHIRT**



# #LGBTSTEM Day



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# JURP

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# Membership Poster

I was taught that the way of progress is neither swift nor easy.

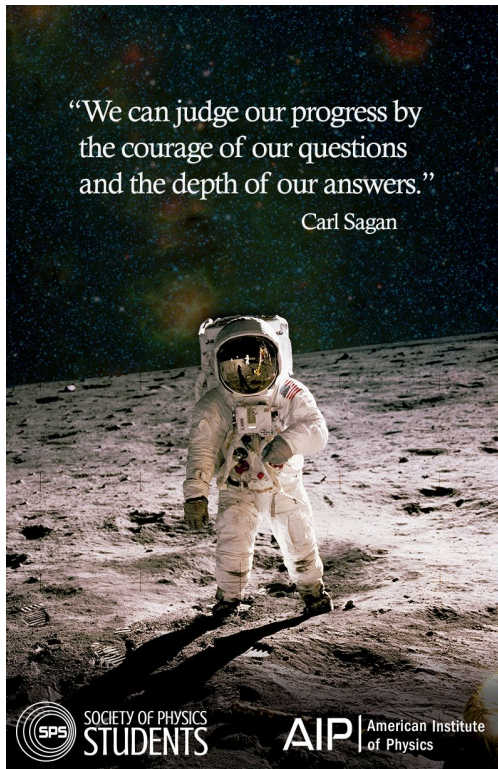
*Marie Curie*



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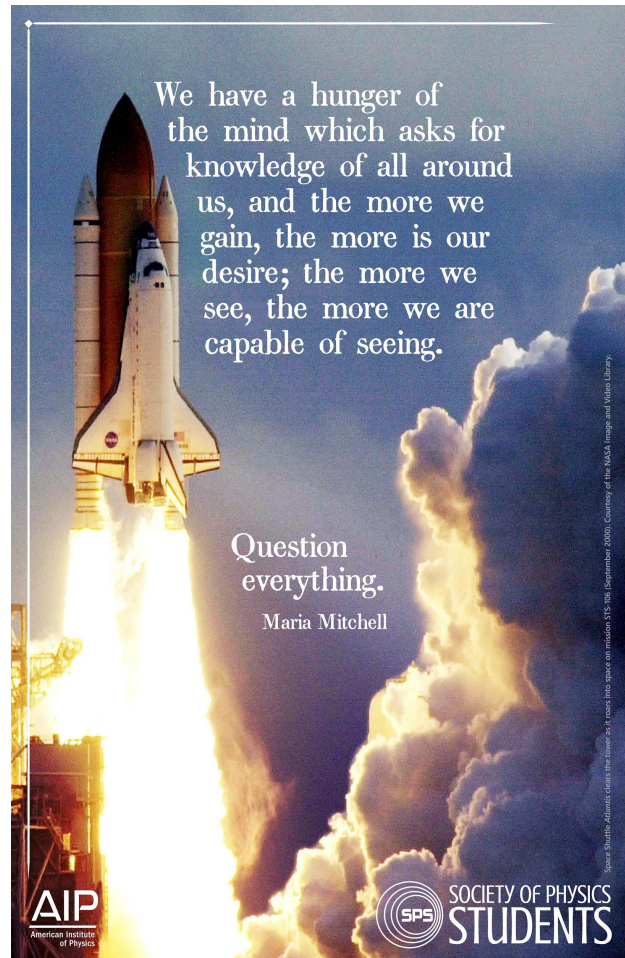


“We can judge our progress by the courage of our questions and the depth of our answers.”

Carl Sagan

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We have a hunger of the mind which asks for knowledge of all around us, and the more we gain, the more is our desire; the more we see, the more we are capable of seeing.

Question everything.

Maria Mitchell

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Space Shuttle Columbia takes space on mission STS-51-L, September 26, 1981. Courtesy of the NASA Image and Video Library.

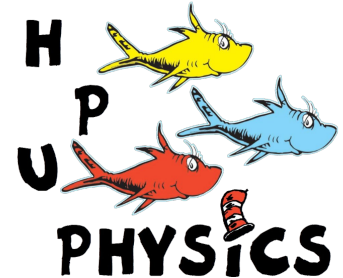
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HPU Physics Department



## 2018 SPS Interns



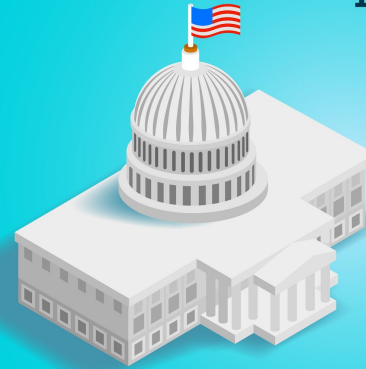


Questions?

# Scientific Illustration



Helping them  
understand  
the **gravity**  
of the  
situation.







Thank you!